Coursework EE303: Communication Systems
"DS/QPSK Spread Spectrum Systems"

Professor A. Manikas
Chair of Communications and Array Processing
Department of Electrical & Electronic Engineering
Imperial College London

November 17, 2018

1 Aims

- The main objective of this assignment-study is to design and analyse the performance of a QPSK Digital Communication System which is then extended to a Direct-Sequence QPSK Spread Spectrum Communication System operating in the presence of a Jammer.

2 Equipment and Software

- PC (operating system Windows 10 or Mac OS)
- MATLAB, Visual C++ or any other suitable language.
- One text file of 300 characters (including spaces) representing the "desired" message for transmission.
- One text file of 300 character (including spaces) representing one co-channel interfering message (jammer).

3 Tasks

- With reference to Figure-1 a message of 300 characters is applied at point A2 of a Digital Communication System (this is the "desired" message).
- The system involves a QPSK modulator with its constellation diagram shown in Figure-2.
- The transmitted signal is corrupted by additive (complex) white Gaussian channel noise and a jamming signal.

    1. Demodulate the received signal and get the message at point $\widehat{\text{A}}_2$ (see Figure-1) and
    2. plot on the constellation diagram the receiver's decision variables

under the following conditions (defining 7 different Tasks)

Task 1: Absence of both noise and jammer [5%]

Task 2: For SNR_{in} =30dB at point $\widehat{\mathrm{T}}$ and absence of jammer [5%]

Task 3: For SNR_{in} =20dB at point $\widehat{\mathrm{T}}$ and absence of jammer [5%]

Task 4: For SNR_{in} =0dB at point $\widehat{\mathrm{T}}$ and absence of jammer [5%]

Task 5: For the Tasks 2, 3 and 4, at point $\widehat{\mathrm{B}}$, what is:

- the total number of bits in error? [6%]
- the bit error probability? [6%]
- the theoretical bit error probability? [18%]

Task 6:

- For a SNR_{in} =30dB at the receiver's input ("desired" signal). In this task the jammer transmits a jamming message of 300 characters, at the same time, on the same frequency band with a power 10dB above the desires signal power . [10%]

Task 7:

- The system of Figure 1 is extended to the spread spectrum communication system shown in Figure 3 and the jammer operates as a "broadband" jammer. With reference to Task 6, the desired PN code and the PN-code employed by the jammers are gold sequences generated using two primitive polynomials as shown below: [40%]

	1st polynomial (m-sequence)	2nd polynomial (m-sequence)
desired:	$D^5 + D^2 + 1$	$D^5 + D^3 + D^2 + D + 1$
Jammer:	$D^5 + D^3 + 1$	$D^5 + D^4 + D^2 + D^1 + 1$

- Please note that the 2nd m-sequence is delayed by k-bits and added (modulo-2) to the 1st m-sequence, where k is the smallest integer that:
  - gives a "balanced" gold sequence and
  - satisfies the inequality:

$$k \geq (\text{alphabetical order of the 1st letter of your surname} + \text{alphabetical order of the 1st letter of your formal firstname}) \bmod 31 \quad (1)$$

4 Main Assumptions

- The system is fully synchronised
- There are no multipaths
- The path coefficient (β) is assumed equal to 1
- The angle ϕ (see Figure-2) is given, in degrees, according to the following expression

$$\begin{aligned}\phi \quad \triangleq \quad & (\text{alphabetical order of the 1st letter of your surname}) \\ & +2 \times (\text{alphabetical order of the 1st letter of your formal firstname}) \end{aligned} \tag{2}$$

- The pn-codes are generated by setting the initial state of the shift register be all ones

5 Deliverable

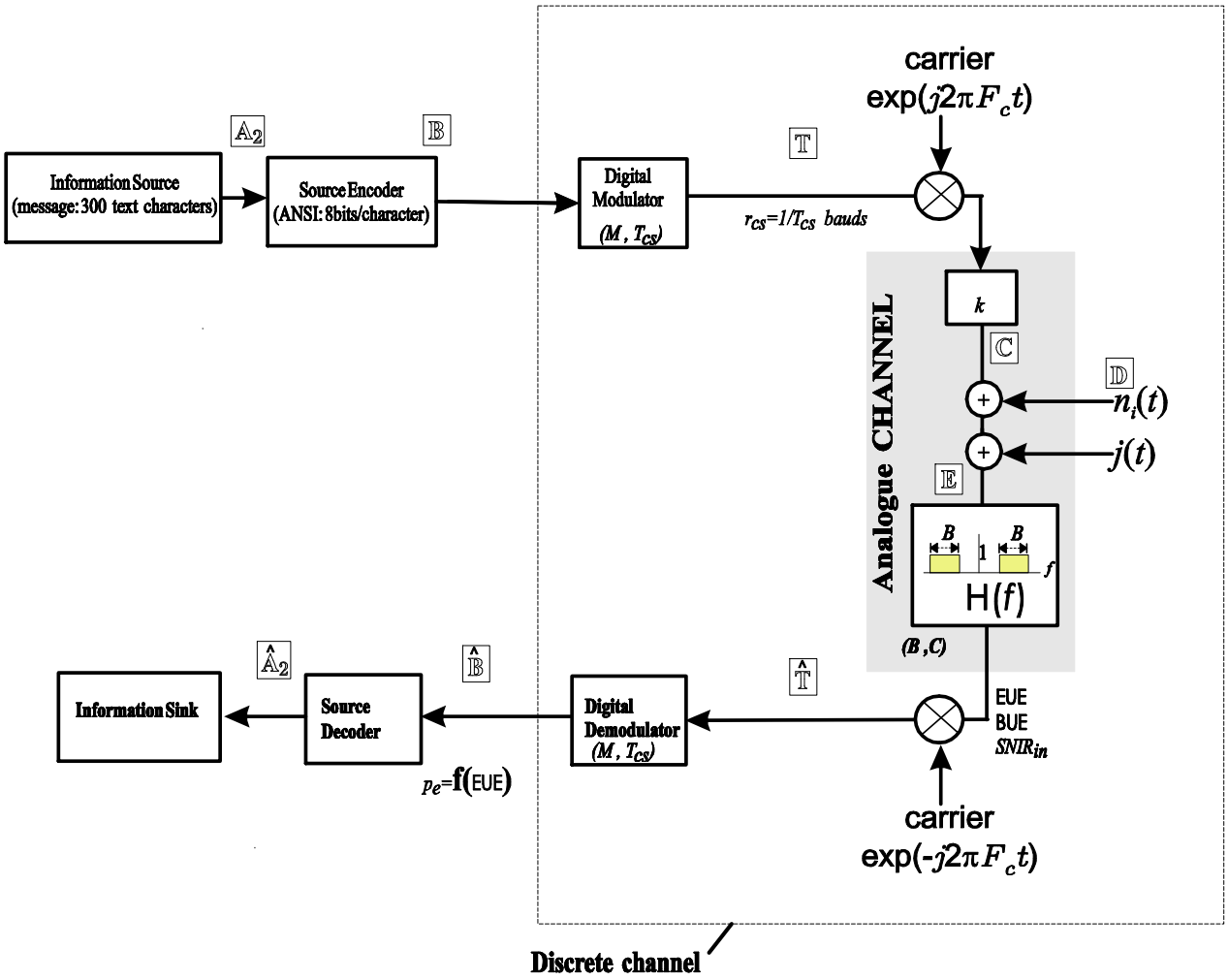
- MATLAB/C file(s) - with brief comments.
- A "pdf" document with the results of the above seven tasks supported by 2-5 lines of some brief comments per task.
- A user interface is useful but not essential.
- Please upload a zip file (including all the files) named by your login name (eg. kl209.zip).

6 Deadline

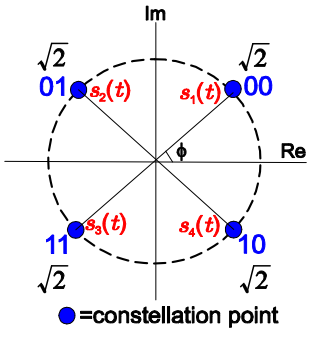
- 5.30pm, Monday 7th Jan 2019 (Week S1, Spring Term).

7 References

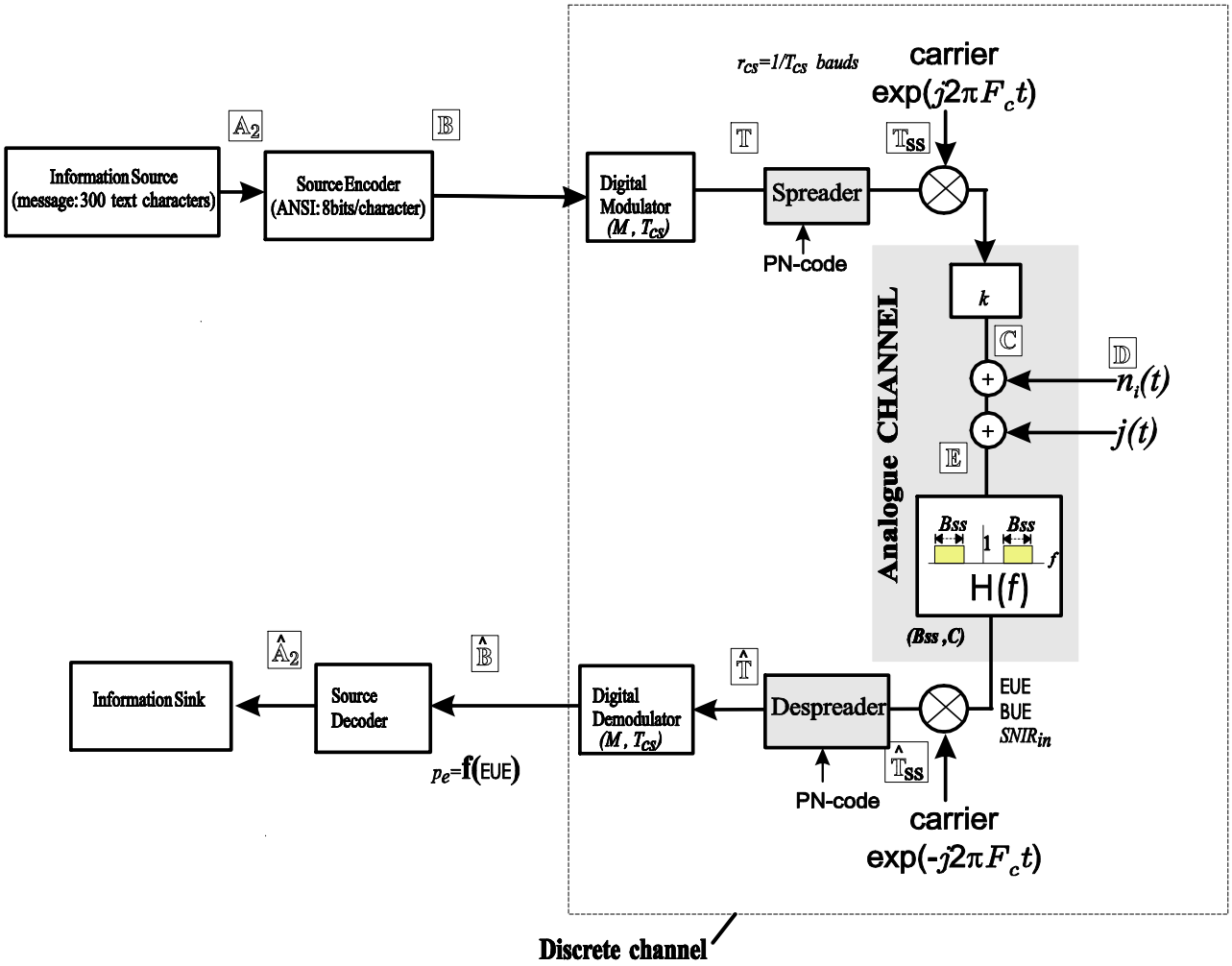
- Lecture Notes on Communication Systems
- your own references.



A Conventional Digital Communication System Operating in the Presence of a Jammer.



QPSK constellation diagram.



A Spread Spectrum Communication System Operating in the Presence of a Jammer.